March 6, 1956 C. M. HARTER 2,737,208

WIRE-WEAVING MACHINE

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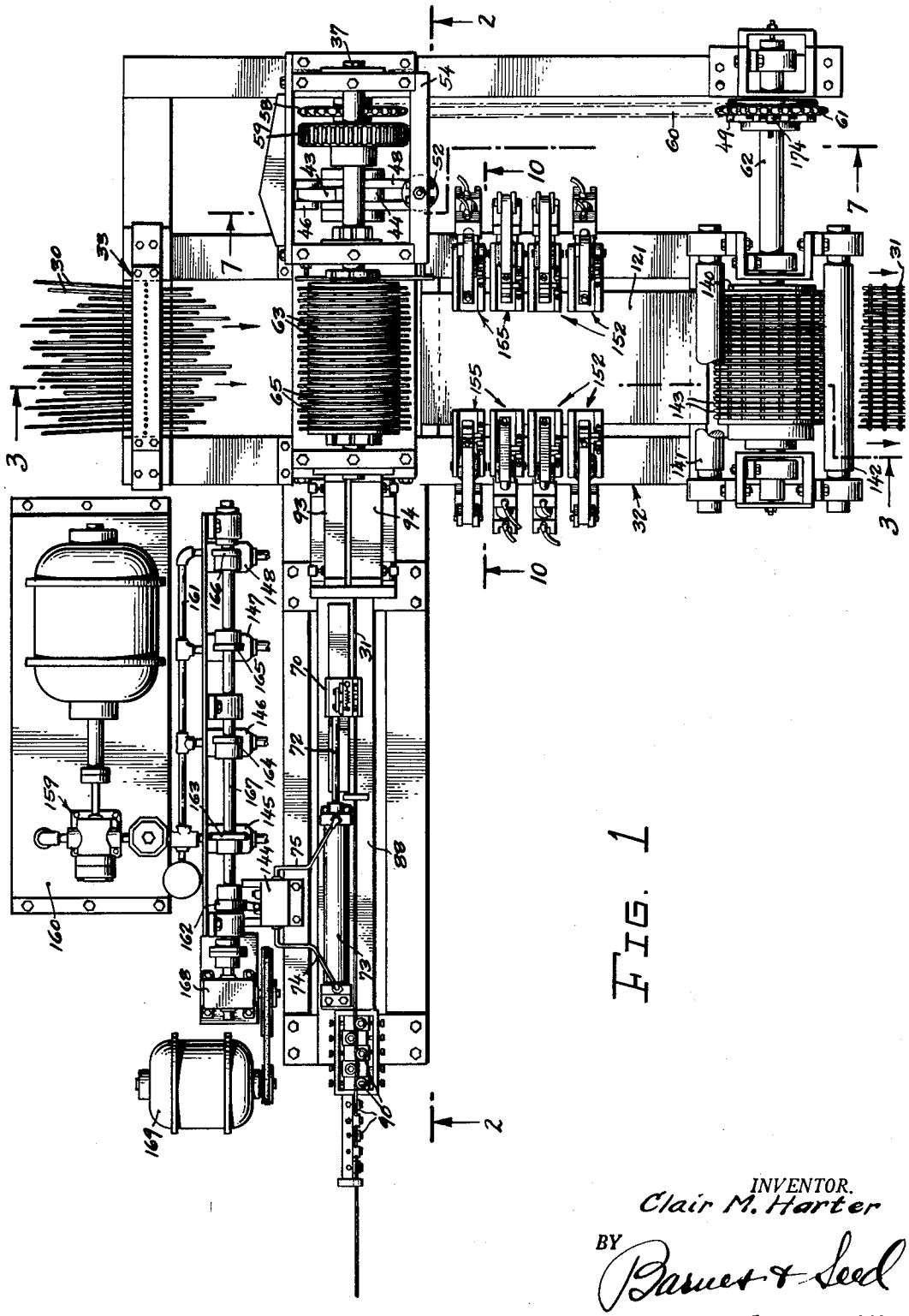


FIG. 1

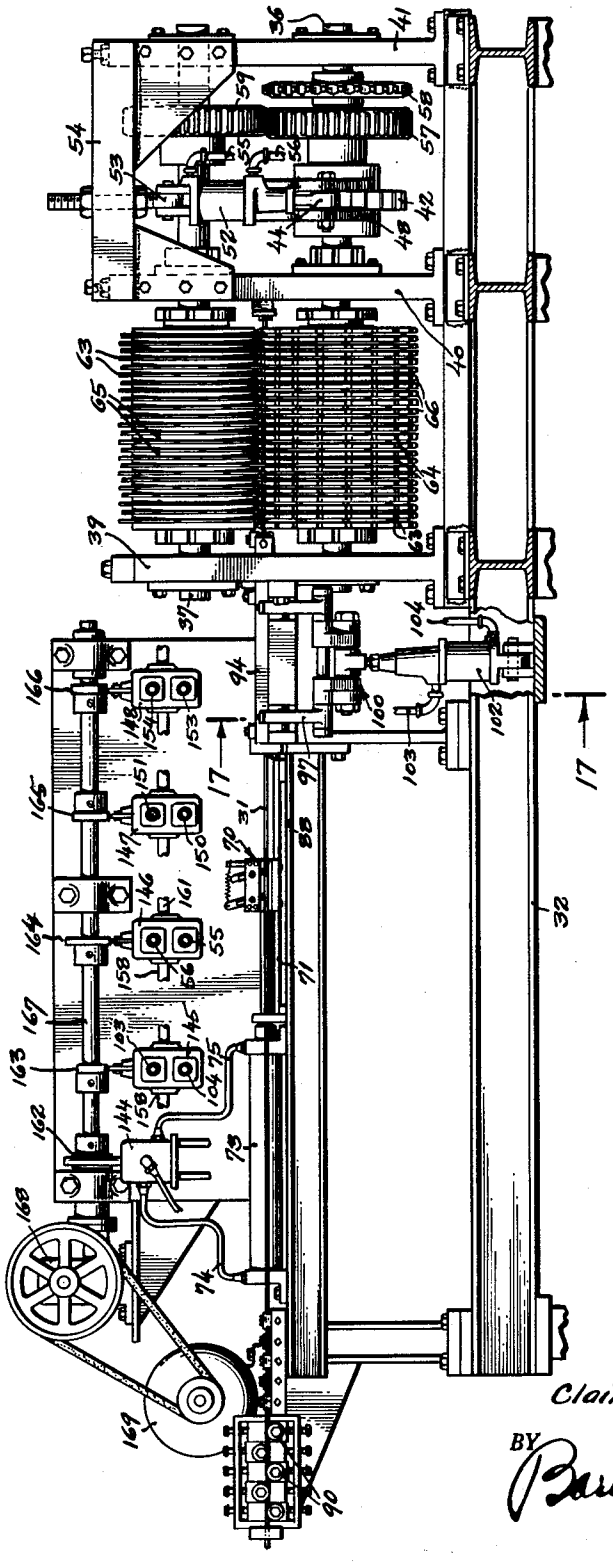
INVENTOR.
Clair M. Harter
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WIRE-WEAVING MACHINE

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FIG. 2




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WIRE-WEAVING MACHINE

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FIG. 3

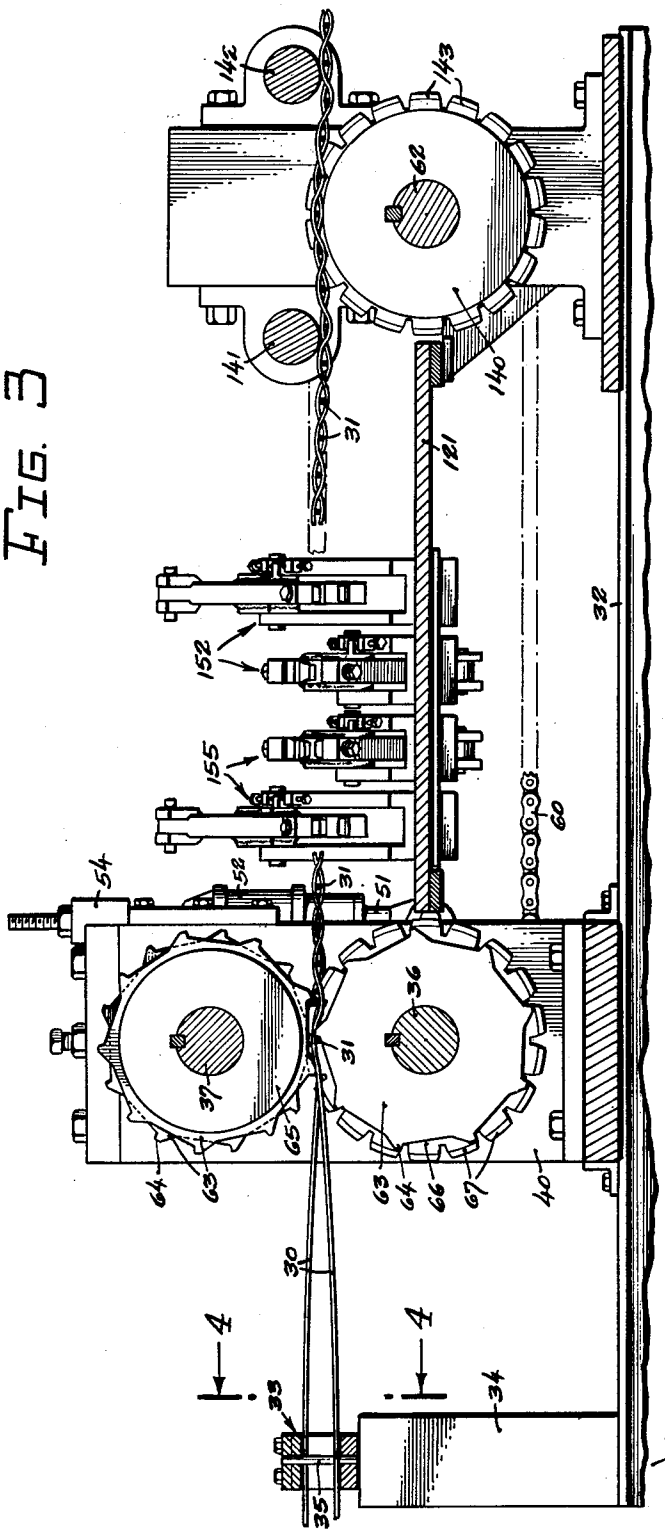
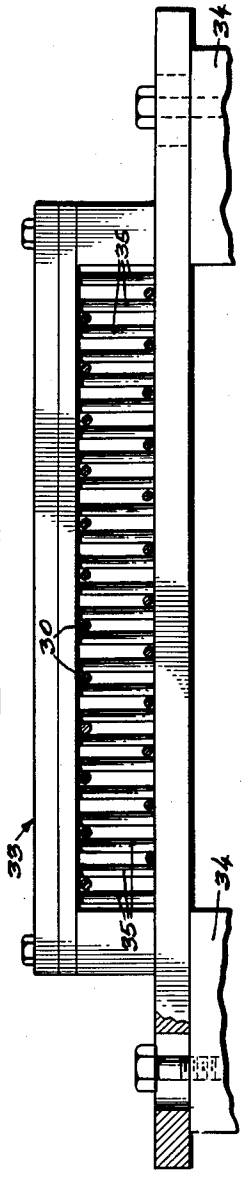



FIG. 4




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WIRE-WEAVING MACHINE

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FIG. 5

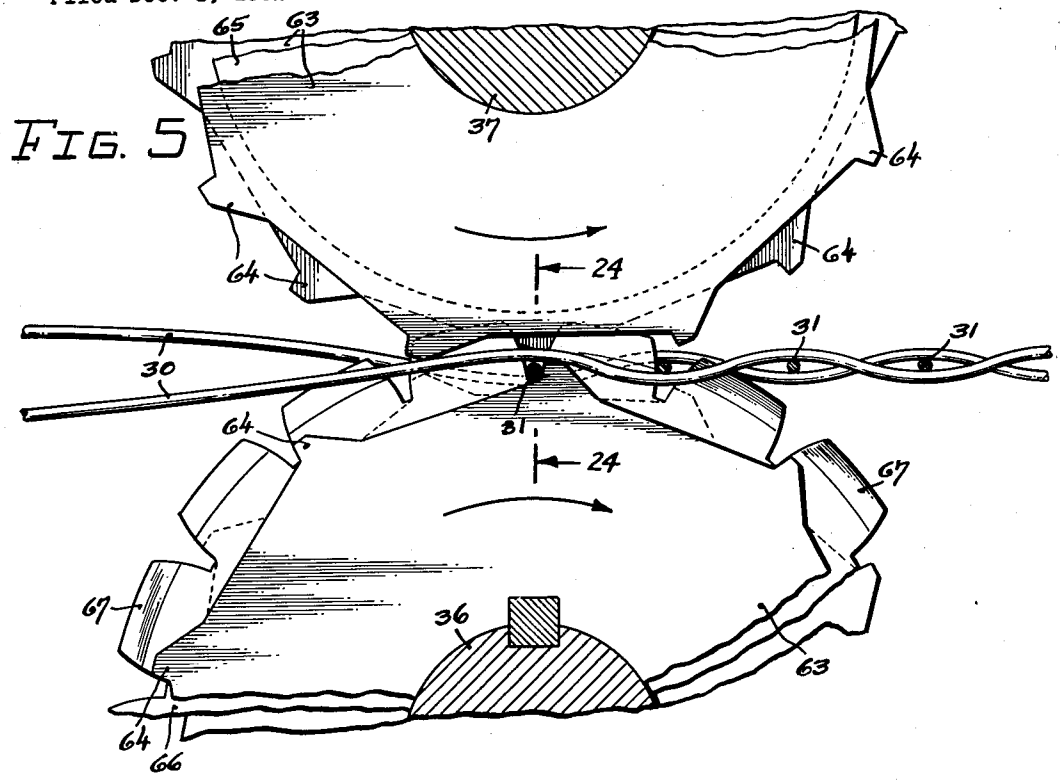
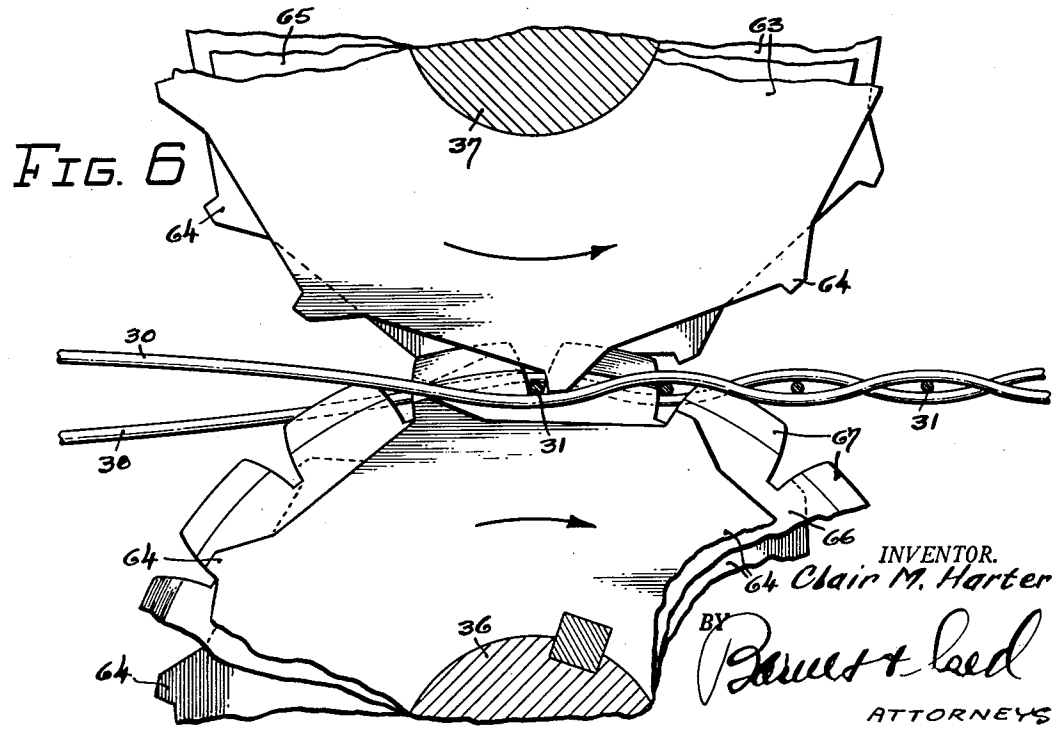



FIG. 6




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FIG. 7

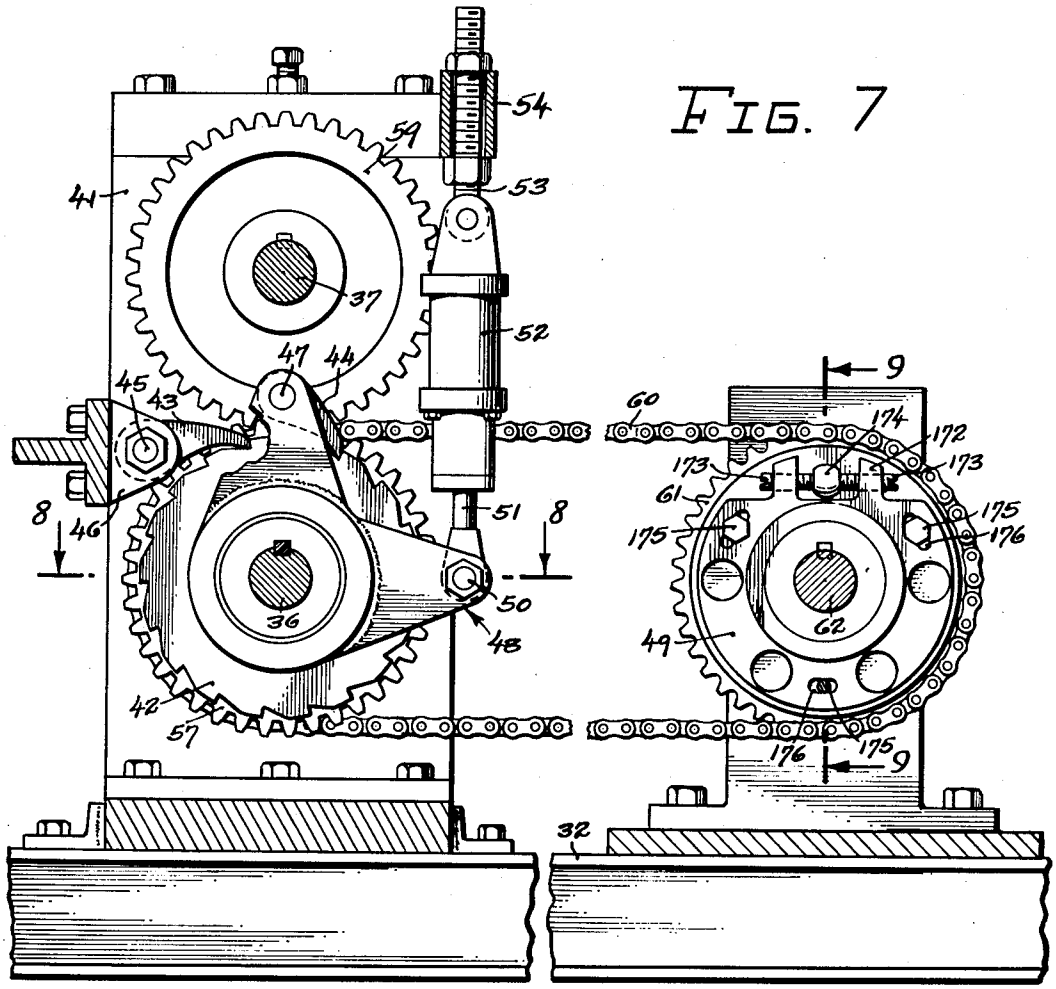



FIG. 8

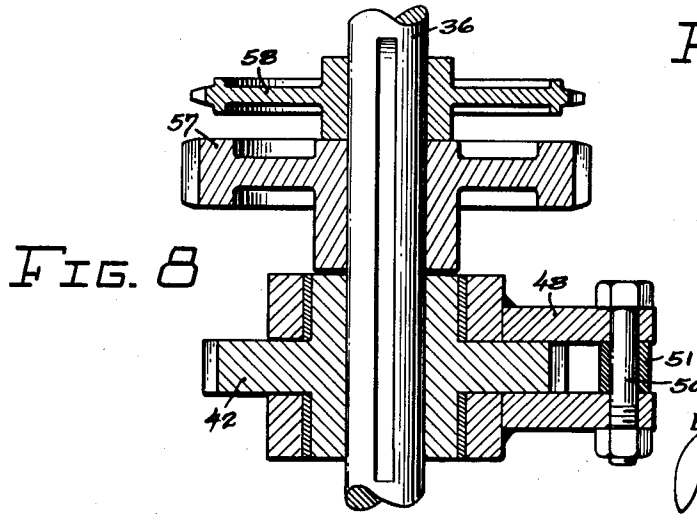
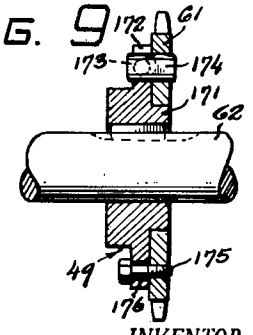



FIG. 9




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WIRE-WEAVING MACHINE

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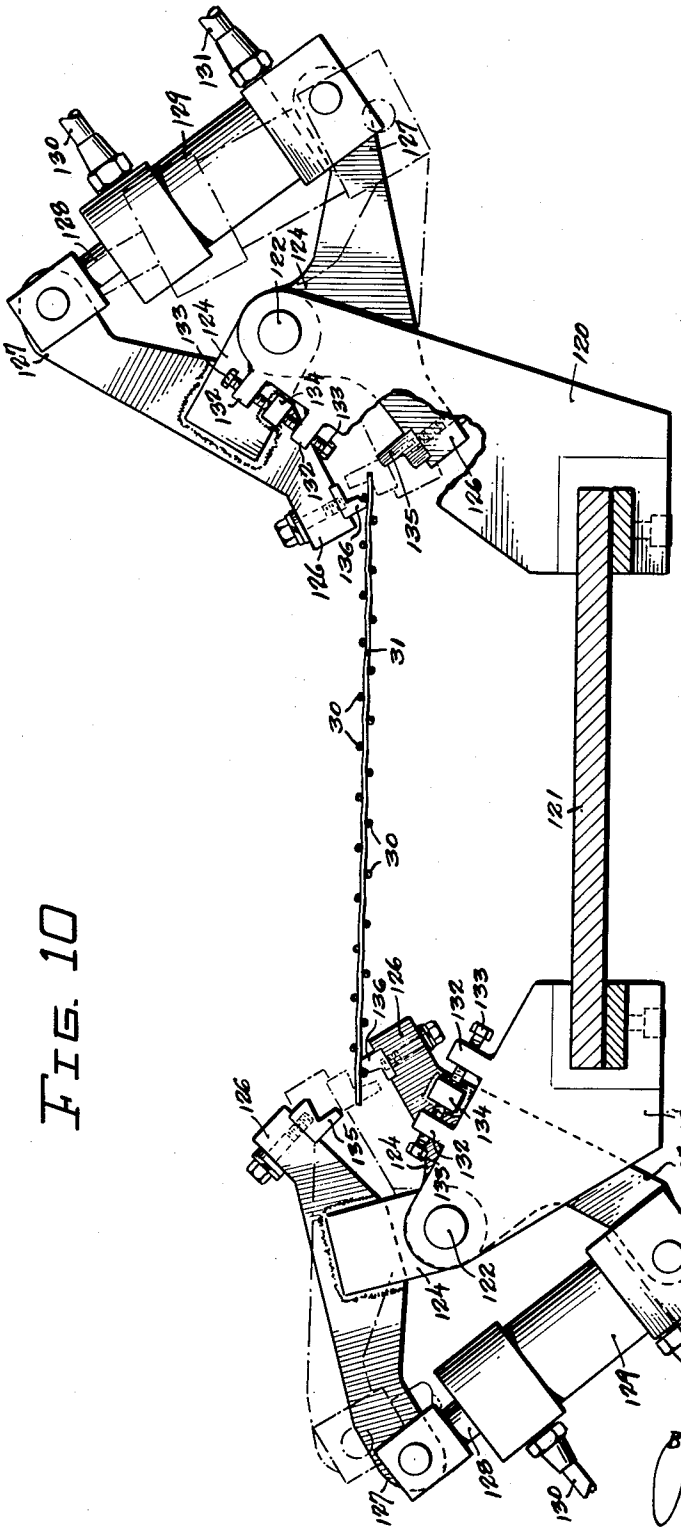


FIG. 10

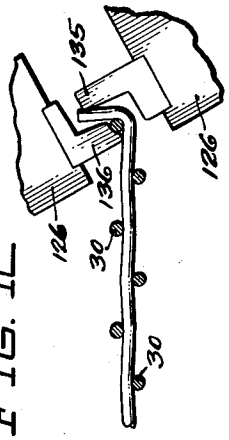


FIG. 12

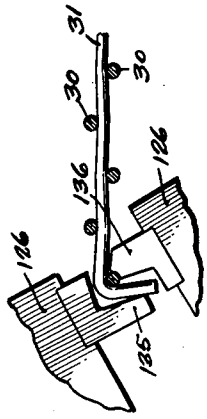


FIG. 11

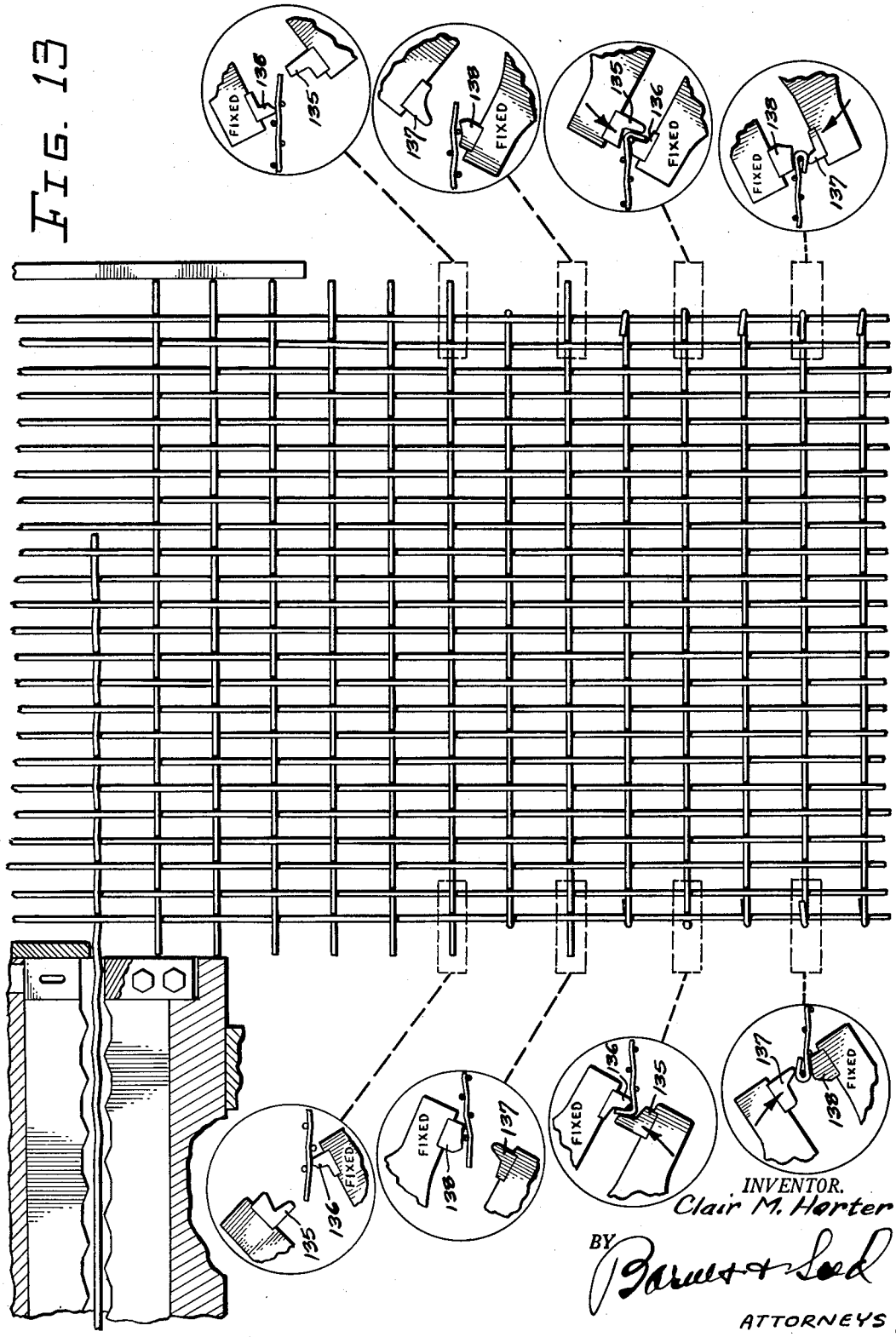
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March 6, 1956 C. M. HARTER 2,737,208

WIRE-WEAVING MACHINE

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FIG. 13




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WIRE-WEAVING MACHINE

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FIG. 14

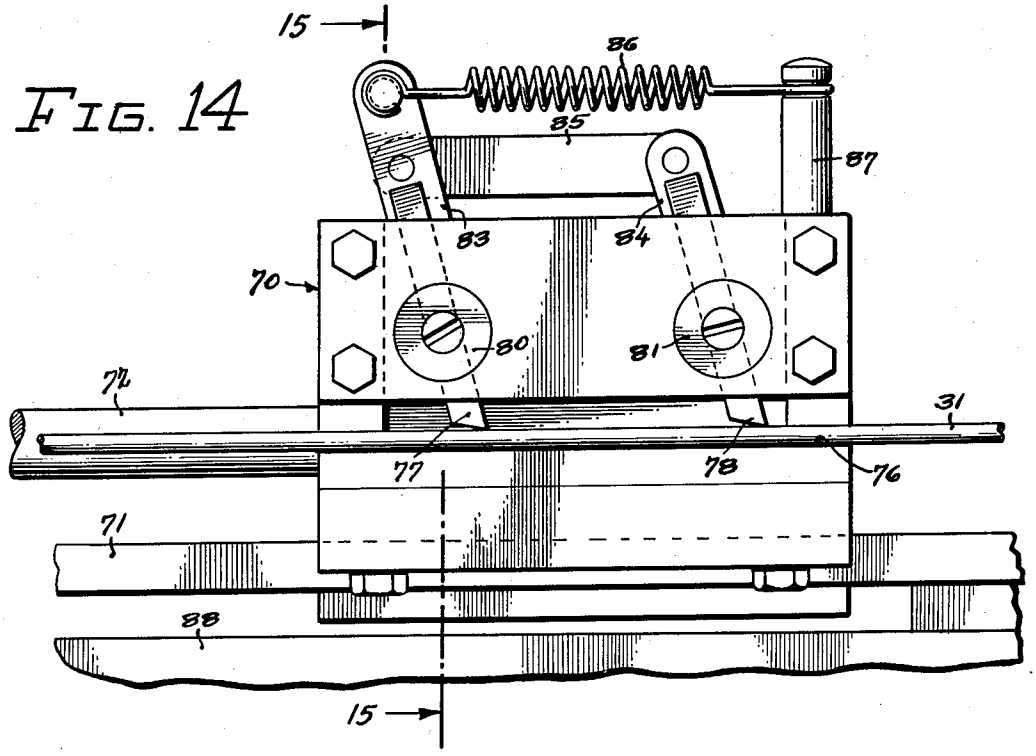
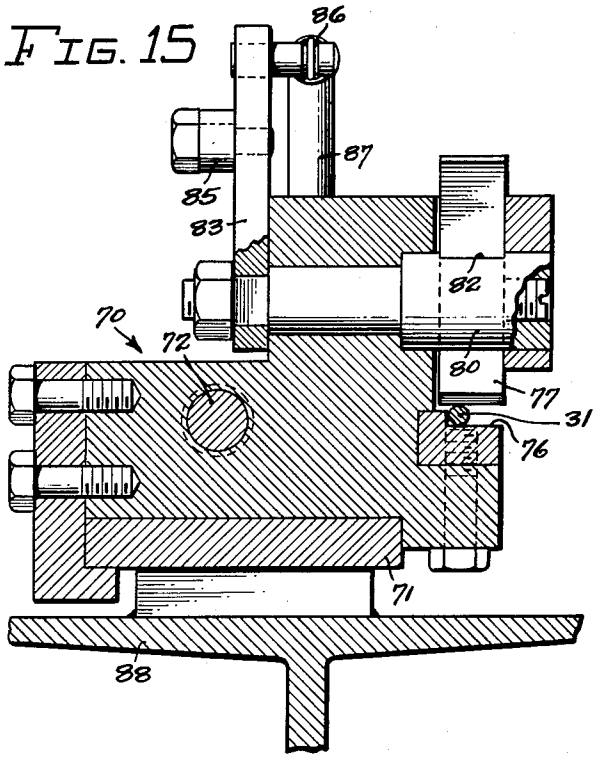



FIG. 15



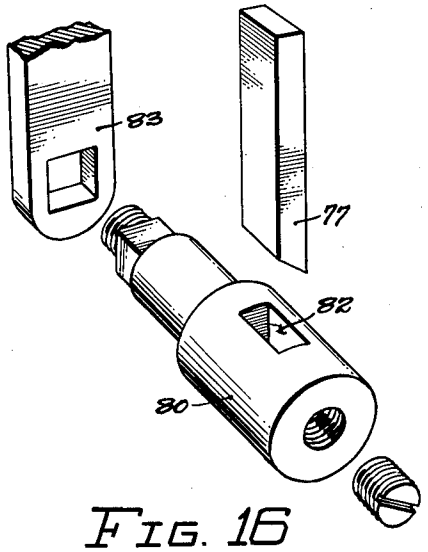




FIG. 16

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WIRE-WEAVING MACHINE

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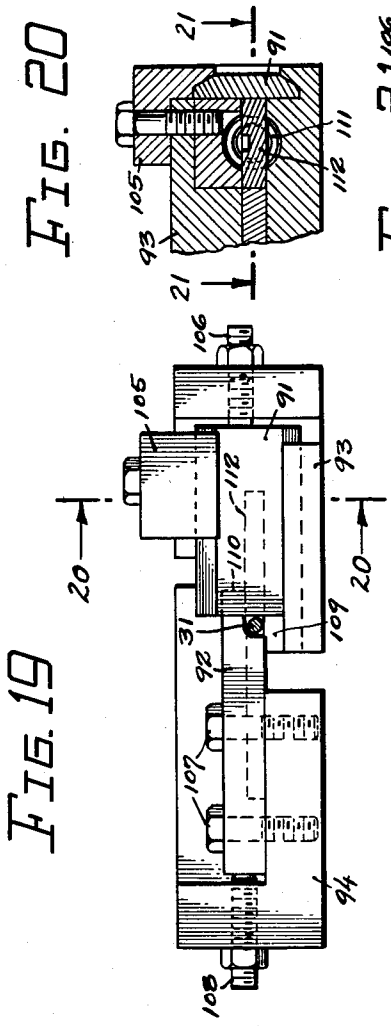


FIG. 19

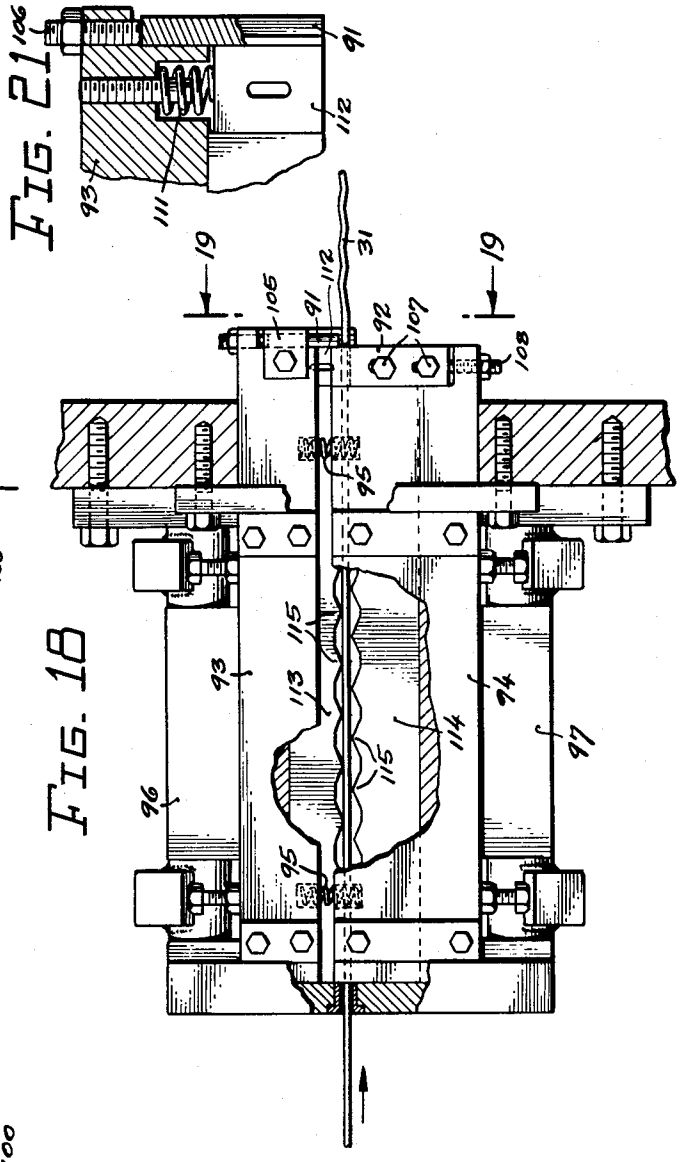


FIG. 18

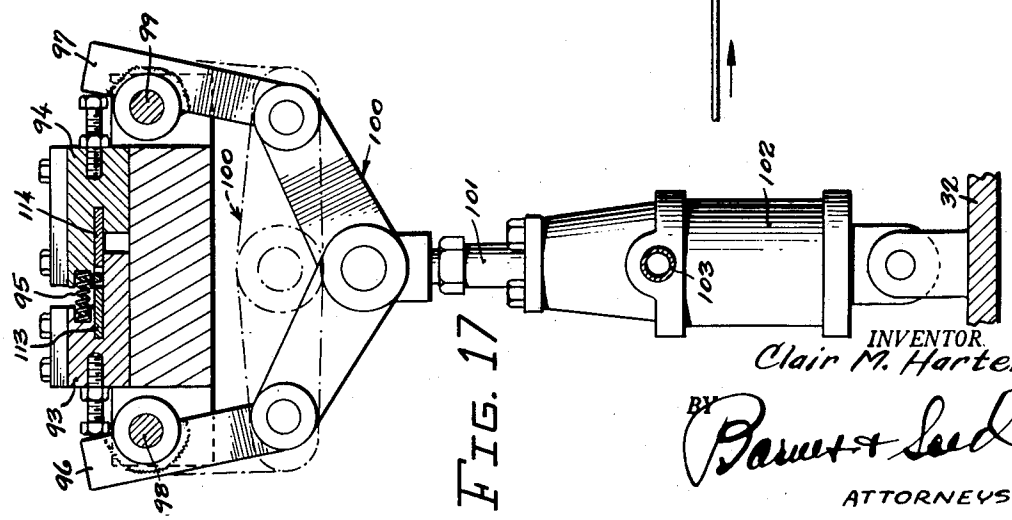


FIG. 17

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WIRE-WEAVING MACHINE

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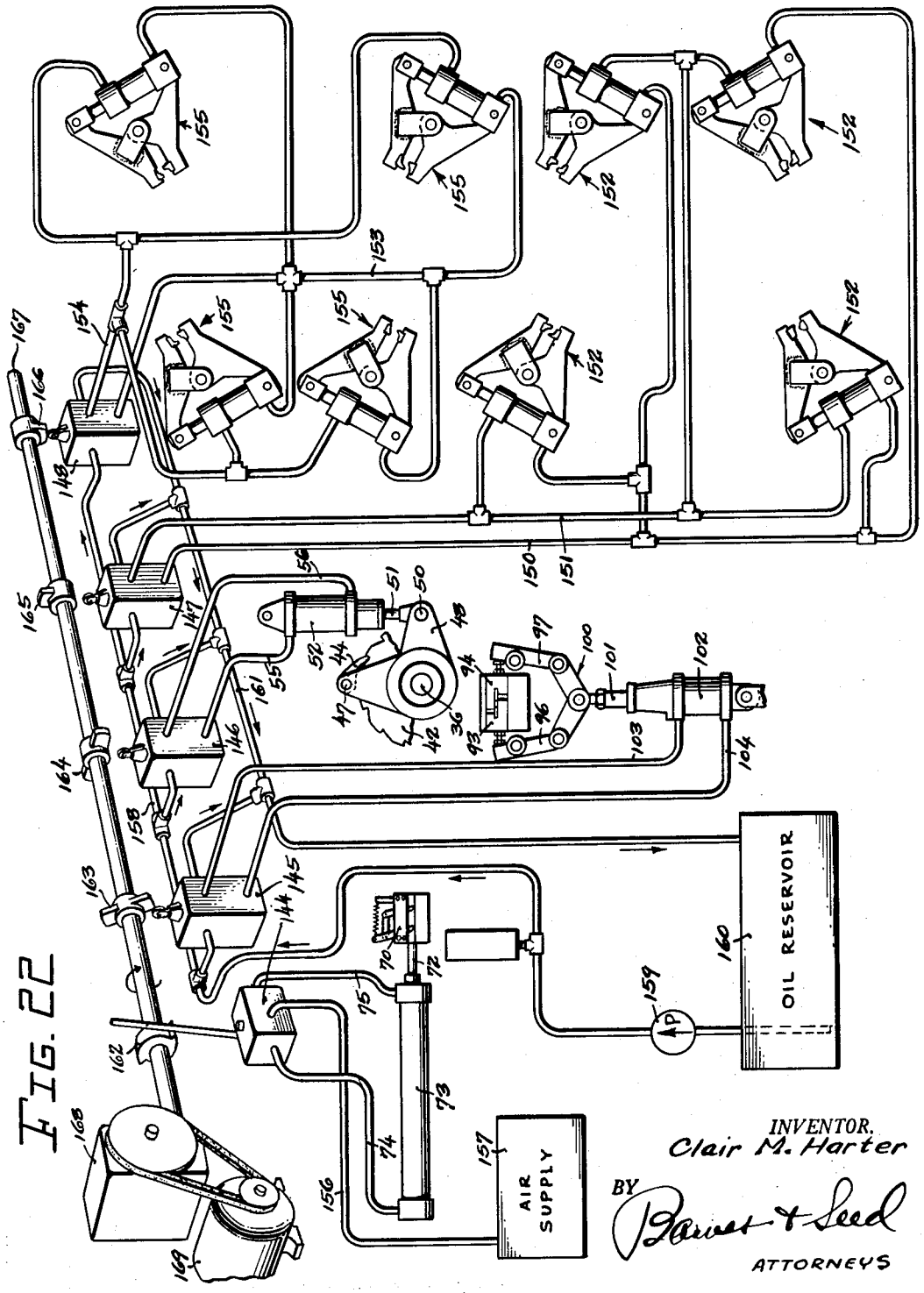



FIG. 22

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March 6, 1956 C. M. HARTER 2,737,208

WIRE-WEAVING MACHINE

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FIG. 23

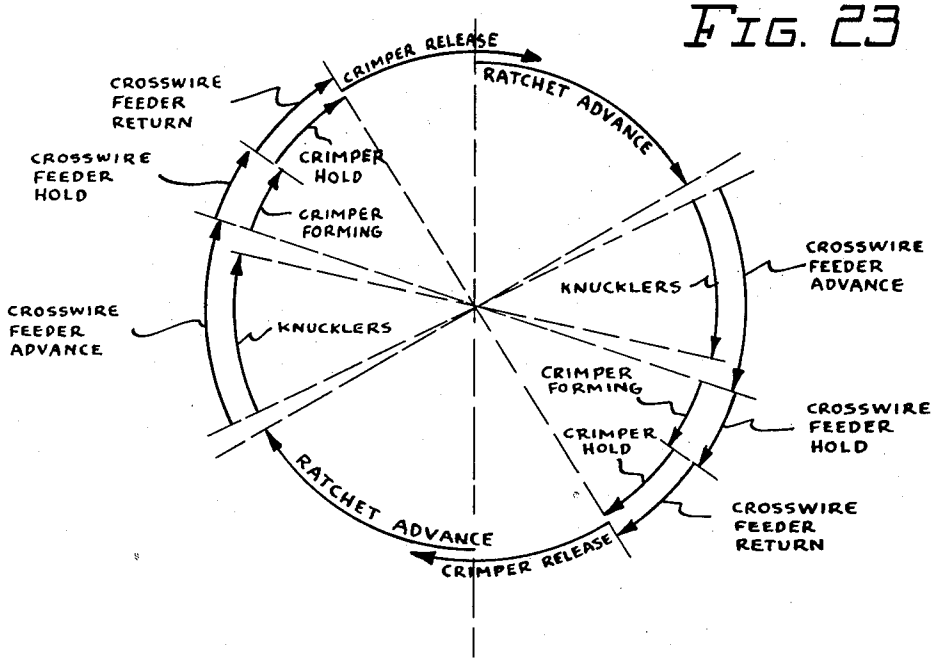



FIG. 24

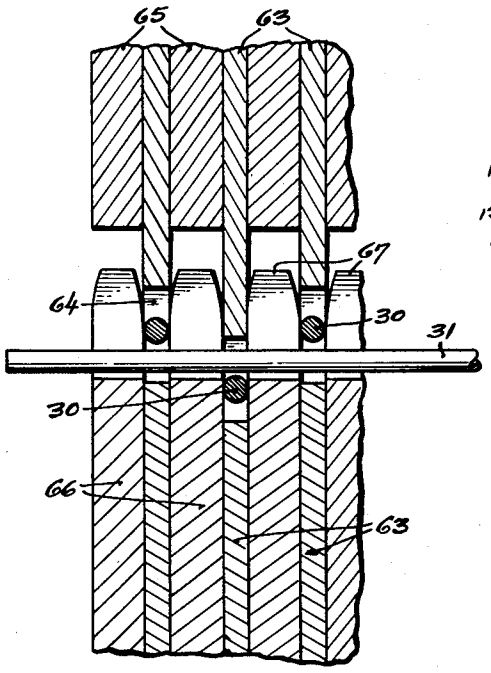



FIG. 25

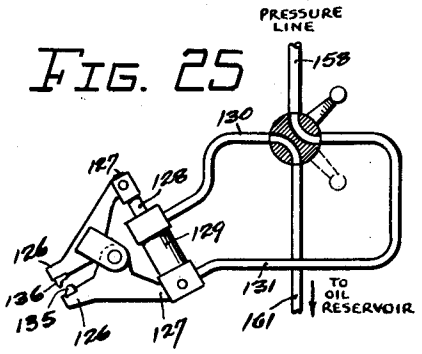
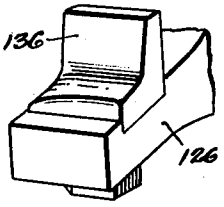



FIG. 26




INVENTOR.
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BY Barnett & Seed

ATTORNEYS

United States Patent Office 2,737,208 Patented Mar. 6, 1956



2,737,208

# WIRE-WEAVING MACHINE

Clair M. Harter, Seattle, Wash., assignor to Pacific Wire Works Co., Seattle, Wash., a corporation of Washington

Application December 8, 1952, Serial No. 324,729

27 Claims. (Cl. 139—28)

This machine relates to a machine and method for weaving wire screens, and for its general object aims to provide a machine and method particularly applicable to heavy-gauge screens, one which permits such screens to be produced to substantially unlimited lengths with the stock material from which the warp and woof wires are produced being drawn from separate supply reels for each of the several warp strands and from a single supply reel for all of the several woof strands, and which causes the warp wires and the woof wires to be both shaped and interwoven automatically in course of progress along guided travel paths.

It is a further and particular object to provide a machine and method for weaving wire screens in which the woof wires are brought into functioning relation to the warp wires by force of following thrust as distinguished from the pull force of the usual reciprocating shuttle, and employing the stiffness inherent to heavy-gauge stock to give a necessary rigidity to the wires being pushed.

As a further object still the invention aims to provide a machine and method operating automatically by progress of the developing screen along a guided travel path to securely clinch projecting ends of the applied woof wires around the side-edge warp wires of the screen being woven.

The invention, with these and other more particular objects and advantages in view and which will each appear and be understood in the course of the following description and claims, consists in the advanced method of weaving a wire screen and in the construction, adaptation, and combination of parts of a machine for practicing said method, as hereinafter described and claimed.

In the accompanying drawings:

Figure 1 is a top plan view of a wire-weaving machine constructed to embody the preferred teachings of the present invention, and incorporating a fragmentary showing of the ultimate woven screen and of the incoming wires which produce the warp and woof strands of said screen.

Fig. 2 is a transverse vertical sectional view on line 2—2 of Fig. 1.

Fig. 3 is a longitudinal vertical sectional view on line 3—3 of Fig. 1.

Fig. 4 is a fragmentary transverse vertical sectional view drawn to an enlarged scale on line 4—4 of Fig. 3.

Figs. 5 and 6 are enlarged-scale fragmentary longitudinal vertical sectional views of the forming wheels of the machine and illustrating such wheels in the two positions which they are successively caused to occupy as turning motions thereof propagate waves in ganged wires which function as the warp strands for the screen being woven.

Fig. 7 is a fragmentary longitudinal sectional view drawn to an enlarged scale on line 7—7 of Fig. 1.

Figs. 8 and 9 are a fragmentary horizontal sectional view and a fragmentary transverse vertical sectional view on lines 8—8 and 9—9, respectively, of Fig. 7.

Fig. 10 is a cross-sectional view detailing the structural nature of jawed knucklers employed in the machine and



which are in sets of two working successively and functioning by the cumulative action of the two sets to bend over and clinch cross-wires around the side-edge warp wires of the screen, the section being drawn to an enlarged scale on line 10—10 of Fig. 1.

Figs. 11 and 12 are enlarged-scale detailed views showing the knucklers of Fig. 10 in the performance of their bending function.

Fig. 13 is a somewhat schematic top plan view, with parts in section, illustrating the steps of feeding cross-wires through eyes produced in the travelling warp wires, and illustrating the positions occupied and the manner of operation of the sets of knucklers, the top plan of these knucklers being indicated by dotted rectangles and elevations thereof being shown in the associated circles.

Fig. 14 is a fragmentary enlarged-scale elevational view detailing the reciprocating shuttle which feeds the cross-wires to the warp wires.

Fig. 15 is a transverse vertical sectional view on line 15—15 of Fig. 14.

Fig. 16 is an exploded perspective view portraying one of the two rocker-mounted wire-gripping dogs of the shuttles.

Fig. 17 is a fragmentary vertical sectional view drawn to an enlarged scale on line 17—17 of Fig. 2.

Fig. 18 is a fragmentary top plan view, with parts in section, of the cut-off and crimping blocks shown in Fig. 17.

Fig. 19 is an end elevational view of said blocks drawn on line 19—19 of Fig. 18.

Fig. 20 is a vertical sectional view on line 20—20 of Fig. 19.

Fig. 21 is a fragmentary horizontal sectional view on line 21—21 of Fig. 20.

Fig. 22 is a schematic view showing certain essential moving parts of the machine together with means including a timing shaft governing the delivery of pressure fluid to cylinders which are responsible for the movement of these parts.

Fig. 23 is a graph of the timing cycle of said timing shaft.

Fig. 24 is a fragmentary enlarged-scale vertical sectional view on line 24—24 of Fig. 5.

Fig. 25 is a schematic view illustrating the oil circuit for one of the jawed knucklers; and

Fig. 26 is an enlarged-scale fragmentary perspective view detailing jaw structure which, other than for differences in the shape of the jaw faces, is typical of all of the jawed knucklers.

Before proceeding with a detailed description of the invention it is thought that clarity in an understanding thereof will be advanced by here cursorily outlining the steps practiced, and the mechanism employed, in producing the wire screen.

The screen is illustrated as containing 24 warp wires, and the procedure is one in which each of these 24 warp strands is drawn from a respective reel of stock material. Leaving the reels, which are journaled for free turning movement upon a transverse horizontal spindle or spindles, the several strands are first fed through interstices described between vertical pickets of a transversely extending fence structure, and lead therefrom as a gang between upper and lower forming wheels. By the action of these wheels each of the wire strands is so deflected in a direction perpendicular to the travel plane of the wires as to propagate a wave and the troughs and crests of these waves alternate as between the adjacent wires of the gang. Viewed from the side there results from the transversely aligned alternating positive and negative waves a substantial eye, convexo-convex in profile, extending from one to the other side edge thereof of the ganged wires, and through this eye I thread a woof or cross-wire some-

what longer than the transverse span of the ganged warp wires so that each cross wire has its two ends projecting laterally beyond the side edge limits of the ganged warp wires.

The forward progress of which the warp wires partake as they move from the supply reels to and beyond the forming wheels is intermittent, and the act of threading the cross-wires through the produced eyes is performed during the momentary intervals when the progress is interrupted. It is to be understood that the threading station is localized with respect to the travel path of the ganged warp wires. At other localized stations along said travel path, functioning likewise during the momentary intervals when progress of the ganged wires is arrested, there are provided means to produce selvage. These means function to clinch the exposed ends of the woof wires around the side-edge warp wires. These wire-clinching devices are composed of sets of jawed knucklers of which there are two jaws in each knuckler and two successively acting knucklers in each set with the first knuckler serving to impart an initiating 90° bend to the concerned wire end and with the second knuckler of the set serving to impart a further 90° bend so as, by the cumulative action of the two knucklers of a set, to effectively clinch the exposed end of the cross wire about the side edge warp wire. There are four sets of knucklers in all, two sets at each side of the advancing woven screen.

The forming wheels, together with a tail wheel which takes a purchase upon the woven screen at a point in the latter's travel path located beyond the knuckling stations, act in concert to give to the warp wires the energy responsible for progress through the various described stages of travel.

The reels from which the wires are drawn are not illustrated in the drawings but the warp wires and the cross-wires are designated by the numerals **30** and **31**, respectively. **32** represents a machine bed and the referred-to fence, designated by **33**, rests upon posts **34** which foot upon such bed at the extreme head end thereof. The pickets of the fence are denoted by **35**.

As respects the two forming wheels, each is a multiple-disc structure, and carrying these multiple discs are transversely disposed shafts **36** and **37** mounted for rotation about vertically spaced horizontal axes. As will be best seen from an inspection of Figs. 2 and 7, the shafts are journaled in bearing boxes carried by three transversely spaced posts **39**, **40**, and **41**. The multiple-disc wheels occupy a position between two of these posts and between the other two posts there is keyed or otherwise secured to the lower shaft **36** a hydraulically-activated means for powering the shaft. Such means consists of a ratchet wheel **42** which is engaged by two pawls **43** and **44**, the pawl **43** being a non-return pawl pivoted as at **45** to a frame-mounted bracket **46**, and the pawl **44** being an activating pawl pivoted, as at **47**, to one arm of a bell-crank **48** loosely mounted on the shaft. The other arm of the bell-crank connects by a pivot pin **50** to the rod **51** of a double-acting piston, and the cylinder **52** for this piston is trunnion-mounted to a hanger **53** which is attached to an overhead frame-piece **54**. Fluid-flow lines to the two ends of the cylinder are denoted by **55** and **56**. Also keyed to said lower shafts are a gear wheel **57** and a sprocket wheel **58**. The gear wheel meshes a complementing gear-wheel **59** keyed to the upper shaft **37** and thus causes the two shafts to turn in concert but in different directions. The sprocket wheel **58** acts through a chain **60**, a sprocket wheel **61**, and a pick-up wheel **49** adjustably secured to the sprocket wheel to pass the power forwardly from the shaft **36** to a forward shaft **62** on which the above mentioned tail wheel, hereinafter to be described, is carried. Both as respects the upper and lower of said forming wheels, the multiple discs of which the same are composed are alternately wide and narrow, comparatively speaking. The narrow discs **63** present about their perimeter a plurality of equidistantly spaced teeth **64**, and to signify a weaving function which these teeth perform the same will be hereinafter termed the heddle teeth. The spacing between these heddle teeth is quite wide by comparison with the circumferential length of the teeth and the arrangement is one in which the upper and lower discs mesh, with each tooth of an upper disc occuring intermediate two teeth of a lower disc. The several discs **63** of each wheel are so mounted in a staggered relation that the teeth of one said disc lie intermediate the teeth of the next adjacent said disc. In point of shape the teeth preferably are flat-faced with a fairly abrupt following edge and having a more moderately sloped leading edge, the inclinations, as here illustrated, approximating 15° and 45°, respectively, from radial planes (see Figs. 5 and 6). As respects the wide discs of said forming wheels, those which occur upon the upper wheel and which are denoted by **65** present a smooth periphery developed concentric to the axis of the wheel on a circumference smaller than the circumference of the heddle discs, whereas the wide discs **66** of the lower wheel present peripheral teeth **67** which project outwardly beyond the related heddle teeth. Such teeth **67** serve the function of drivers and will be hereinafter so termed. There are twice as many driver teeth on each driver disc as there are heddle teeth on each heddle disc and the placement is such that successive driver teeth of each driver disc have their following edge transversely aligned one said tooth with the following edge of a heddle tooth disposed at one side and the other said tooth with the following edge of a heddle tooth disposed at the other side of the concerned driver disc.

In a manner which will hereinafter become apparent, the ganged warp wires advance a distance approximating the rim travel of said forming wheels during each of the interrupted turning motions of the forming wheel, and it will also be apparent that staggered upper and lower forming teeth of the forming discs will, by this movement, propagate a wave in the advancing wires, with the wave being positive as respects one wire and negative as respects the next adjacent wire. It is during the momentary interval when the warp wires come to rest following the performance of each of said interrupted waving actions that I cause the cross-wires **31** to be threaded successively through each of the transversely extending convexo-convex eyes which the ganged warp wires present.

A fairly stiff stock is used for the cross-wires **31** and this stock is pushed through the eye by the action of a shuttle **70** movable reciprocally along a transverse horizontal path located to one side of the forming wheels. The shuttle is carried for endwise sliding movement by a guide rail **71** and receives travelling energy from a piston rod **72** having its piston working in a pressure-air cylinder **73**. Pipes **74** and **75** lead to the two ends of this cylinder. The stroke of the shuttle is somewhat longer than the transverse span between the side edges of the ganged warp wires and its movement is so coordinated with the interrupted travel of the warp wires that the shuttle moves directively toward the forming wheels when the warp wires are at rest. Provided by the shuttle and acting with a wire-sustaining ledge **76** so as to grip and release the wire stock in the motion of the shuttle toward and from the forming wheels, respectively, are two dogs **77** and **78** carried by rotatable fulcrums comprised in each instance of a journaled spindle, as **80** and **81**, presenting at one end a diametrical opening **82** through which the dogs are adjustably received and having attached to the other end a respective one of two parallel links **83** and **84**. A reach rod **85** connects the two links for unitary movement, and a spring **86** extends from a prolongation of one of said links to a post **87** so as to impose a yielding clockwise motion upon the rotatable fulcrums tending in the shuttle's advance stroke of reciprocation to establish a biting grip from the levers upon the cross-wire stock.

A bench designated by **88** gives support to the guide rail **71** and to the cylinder **73**, and there is also supported by this bench at the inner and outer ends thereof a wire cutter and a set of tensioned pressure rolls, respectively.

The tensioned rolls **90** serve to straighten the wire stock as the latter is drawn from a reel therefor (not shown), and the office of the cutter is to clip the wire to length, this clipping function being performed upon the wire stock only when the leading end has been projected by action of the shuttle through a produced eye of the ganged warp wires. Such clipper consists simply of a shearing blade **91** working across the face of a complementing plate **92**, with the blade being carried by one and the plate by the other of two opposed blocks **93** and **94** which are mounted for horizontal sliding movement toward and from one another. Engaging the backs of these jaws so as to intermittently close the same against the yielding resistance of springs **95** are rocker arms **96** and **97**. Such arms, which rock about the axis of pivot pins **98** and **99**, connect by a toggle joint **100** with a piston rod **101**. The piston associated with this rod is double-acting and is received in a trunnion-mounted hydraulic cylinder **102** fed with pressure fluid by pipes **103** and **104**.

The shearing blade **91** and its complementing plate **92** each admit of being adjustably secured relative to the related block, and the means provided for this purpose comprises for the blade **91** a clamping cap-piece **105** and a backing screw **106** and, for the plate, clamping cap-screws **107** and a backing screw **108**. As can be best seen from an inspection of Fig. 19 the wire stock rests upon a ledge prolongation **109** of the block **93** and is held thereon by an overhanging lip **110** presented by the plate **92**. The wire is caused to bear constantly against an end shoulder of the plate by force exerted from a spring **111** upon a slidably mounted thrust-plate **112**.

While it is normally unnecessary to crimp the cross-wire stock preliminary to the threading of the same through the eyes which are successively produced in the ganged warp wires, pre-crimping is in some instances desirable. For this purpose the two blocks **93** and **94** are provided in their opposed faces with longitudinally extending transversely aligned horizontal grooves (see Fig. 17), and removably socketed in these grooves are jaws **113** and **114** each formed along its inner edge with a series of uniformly spaced dentate teeth **115**. These jaw-teeth interfit, by which I mean that each apex of one plate registers with a hollow or sine of the other, and the spacing between adjacent apices in the two series of teeth corresponds to the spacing between adjacent warp wires. When the blocks are fitted with said crimping jaws it will be apparent that the interfitting teeth perform their crimping function coincident with the shearing of the wire, the said crimping being perforce upon a length of the wire stock which lies in following relation to that length of the wire stock which is being cut off.

As previously stated, each of the successively applied cross-wires projects by each of its two ends laterally beyond the side-edge limits of the ganged warp wires and as the developing screen moves beyond the forming wheels along its defined travel path these projecting ends are folded back and forcefully clinched around a related side-edge warp wire by operation of the referred-to jawed knucklers. Four of such knucklers are provided along each side of the travel path, spaced at equidistant intervals corresponding to twice the center-to-center spacing of the cross-wires. The first two and the last two of said knucklers can be each considered as complements of a respective set and the activation is one in which the two knucklers of the first or upstream set work in concert and alternate in their operation with the concerted working of the last or downstream set. As here shown (see Figs. 13 and 22) the upstream knucklers at the starboard side and the downstream knucklers at the port side of the machine act in each instance to clinch those cross-wires which must be bent upwardly around the side warp wires. The downstream knucklers at the starboard side and the upstream knucklers at the port side conversely act upon the cross-wires which must be bent downwardly. The knucklers are timed so that the alternating operations coincide with the momentary interruptions of the forward progress of the developing screen, one pair of knucklers working during one period of interruption and the other pair of knucklers working in the succeeding period of interruption. As these interruptions occur the two cross-wires which are to be engaged by the respective knucklers are caused to be localized in positions such that the projecting free ends of the wires lie between the knuckler jaws.

Support for the knucklers is derived from respective mounting brackets **120** which are adjustably secured to a frame-carried platform **121** underlying the travel path of the developing screen. The knucklers are different, one as respects the other in a set, but one set is essentially the same as another set and a detailed description of one such set will therefore suffice for the others. As between the two knucklers in a set, the one which lies "upstream," relatively speaking, performs its wire-bending function in advance of the other and the bend which it imposes upon the wire is somewhat more than 90°. The complementing knuckler of the set, lying "downstream" in relation to such first acting knuckler, imposes a further approximate 90° bend so that, cumulatively, the two knucklers produce a bend slightly greater than 180°, hence effectively clinching the free end of the wire around the concerned side warp wire.

As will be clear from an inspection of Fig. 10, there is made fast to each of said mounting brackets a respective pivot pin **122** positioned with its axis paralleling the travel path of the wire screen, and journaled by a respective leg section **124** upon this pin so as to have the cross-arm of one lie above and the cross-arm of the other lie below a plane traversing the pivot pin are two foot-shaped levers. Said leg sections are offset from one another so that the two cross-arms occupy a common transverse vertical plane. The opposing jaws of the respective knucklers are fixed to the toe sections **126** of said cross-arms. There is pivoted to the heel section **127** of one of said cross-arms a piston rod **128**, and pivoted to the heel section of the other cross-arm is a complementing hydraulic cylinder **129**. Pipes for delivering pressure fluid to the two ends of said cylinder are designated by **130** and **131**. One of the two jaws of a set partakes of swing movement as the jaws perform their wire-bending function. The other jaw is stationary. The purpose in having the lever which carries this stationary jaw fulcrumed upon the pivot pin **122** is thought to be self-evident, and namely to provide for swing adjustment of the stationary jaw about the center of said pin as an axis. For fixing the lever in this adjusted position the mounting bracket presents a pair of spaced ears **132**, and opposed set screws **133** threaded through these ears act to engage a projecting lug **134** of the lever. The design of the two brackets for each set of knucklers is such that the pivot pins **122** thereof are removed outwardly beyond the side-edge limit of the advancing screen, and for each set of two knucklers the pivot pin of one is located above while the pivot pin of the other is located below the horizontal plane occupied by the screen. The determining factor as to whether the pivot pin of the first-acting knuckler is located above or below the plane occupied by the screen is the direction, upwardly or downwardly, in which the cross-wire must be bent in order that it will be clinched around a side warp wire. Expressly stated, if the bending action is to be downwardly, the axis about which the moving jaw of the first-acting knuckler swings is then located below the plane occupied by the screen. A reverse situation perforce prevails when the cross-wire is to be bent upwardly. Insofar as the first-acting knucklers are concerned the movable and stationary jaws thereof are de-

noted by 135 and 136, respectively. For the second-acting knucklers said movable and stationary jaws are designated by 137 and 138, respectively.

The shape of these several jaws and the manner in which they perform the function for which they are intended will be apparent from an inspection of the drawings, and particularly Figs. 10 through 13, inclusive. For a most effective clinching of the cross-wires it is desirable that the bent free end pass to one side of the parent cross-wire and I find that I can accomplish this end by rounding off a corner of the fixed jaw of the first-acting knuckler, as shown in Fig. 26, the result whereof is to deflect the free end laterally in a moderate degree.

Proceeding beyond the knucklers the woven screen is caused to be engaged by the referred-to tail wheel. This tail wheel is a laminated structure much the same as the lower of the two forming wheels excepting that the heddle discs 63 are replaced by annular discs 140. Free-running rollers 141 and 142 hold the screen upon said tail wheel so as to assure a purchase from the driving teeth 143 to the successive cross-wires 31.

For controlling the delivery of pressure fluid to the cylinders of the several described double-acting pistons, and namely the pistons for the shuttle 70, for the cut-off and crimper blocks 93—94, for the ratcheting pawl 44, and for the sets of upstream and downstream jawed knucklers, there is provided a set of five interrelated two-position slide valves, and housing these slide valves are respective chests, as 144, 145, 146, 147, and 148. Chest 144 connects by the pipes 74 and 75 with the inner and outer ends of the cylinder 73. Chest 145 connects by the pipes 103 and 104 with the inner and outer ends of the cylinder 102. Chest 146 connects by the pipes 55 and 56 with the inner and outer ends of the cylinder 52. The remaining two chests 147 and 148 connect one through manifolds 150 and 151 with inner and outer ends, respectively, of all four of the downstream knucklers, designated generally by 152, and the other through manifolds 153 and 154 with inner and outer ends, respectively, of all four of the upstream knucklers, designated generally by 155.

As can be best seen from an inspection of Fig. 22, chest 144 also has an inlet port connecting by a pipe 156 with a pressure air tank 157 and presents a suitable air-dumping port open to the atmosphere. The other four chests likewise present inlet and outlet ports connecting the former by a common manifold 158 with a pump 159 fed from an oil reservoir 160 and the latter by a common manifold 161 discharging into the reservoir. The arrangement is one in which each of the several slide valves are spring-loaded so as normally to hold the valves in positions whereat pressure fluid is delivered to those ends of the cylinders which retract the shuttle, open the cut-off and crimper blocks, retract the ratcheting pawl, and open the knucklers. To move the valves to the other of their two positions, so as responsively to advance the shuttle, close the cut-off and crimper blocks, advance the ratcheting pawl, and alternately close the downstream and upstream sets of knuckler jaws, there is provided a respective cam, as 162, 163, 164, 165, and 166. A shaft 167 common to these several cams is powered from the output end of a gear box 168 having its input end belt-driven from an electric motor 169. Three of the five cams, and namely the cams responsible for controlling the timed activation of the shuttle, the crimping and cut-off block, and the ratcheting pawl, each crest twice in a single revolution of the cam shaft. The other two cams, and namely the cam 165 for the downstream knucklers 152, and the cam 166 for the upstream knucklers 155 are each a single-cresting cam. The order and duration of the recurring actions taking place in the present machine can be seen from an inspection of the timing cycle shown in Fig. 23. From 0° to 60° in a single revolution of the timing shaft 167 the ratcheting pawl 44 advances the forming wheels and the tail wheel. The developing bend here imposed by the forming wheels upon the ganged warp wires corresponds to one-half of a complete wave, and which is to say one-half the distance between corresponding points in the same phase of a propagating series of waves. From 65° to 100° the shuttle 70 advances the cross-wire to thread the same through the produced eye of the now-arrested warp wires, and more or less coincident with this feeding of the cross-wire the jaws either of the upstream or of the downstream knucklers, as the case may be, are moved into their wire-bending closed positions. If the relationship, as between warp wires and cross-wires, which we now presume to exist is as shown in Fig. 13, it is the downstream knucklers 152 which are here caused to close, the upstream knucklers being inactive. From 110° to 150° the blocks 93—94 close upon the cross-wire stock so as to cut off the section of wire which the shuttle previously threaded through the produced eye of the warp wires and at the same time crimp a following length of the cross-wire stock. It is here pointed out that this crimped length of wire, when it is later fed through the eye next formed by the forming wheels, positions its crimps in the horizontal plane containing the lines of propagation of the waved warp wires and rotates 90° into its required position only after it is cut off. The crimping and cut-off blocks remain closed, so as to clamp the cross-wire stock through an additional 30° of the timing shaft's movement, and during this clamping period the shuttle 70 returns to the rear extreme of its reciprocal travel, whereupon the blocks 93—94 open. The actions which are above set forth for the first one-half of the timer shaft's 360° cycle of movement are duplicated in the second one-half of such cycle excepting that in this latter instance the upstream knucklers are active and the downstream knucklers stay inactive.

A feature of the invention which is of major importance is the provision of means by which the tail wheel admits of being secured in rotatably adjusted position relative to the driven sprocket wheel 61. The significance of this adjustment is readily understood when it is appreciated that an even mesh can only be assured when the spacing between an active tooth or teeth 143 of the tail wheel and a similarly placed active tooth or teeth 67 of the forming wheel, is an exact multiple of the length of the wave propagated by the heddle teeth. While this wave may vary, as between different runs of wire, in only a minute degree, I have found that without provision for a compensating adjustment the woven product is not only inferior but the machine itself may hang up. The means by which my adjustment is made is detailed in Figs. 7 and 8 wherein it will be seen that the pick-up wheel 49 is keyed to the shaft 62 and that the sprocket wheel 61 is mounted for moderate rotary shifting movement upon the hub 171 of said wheel. To fix the sprocket wheel in rotatively adjusted position relative to the pick-up wheel a radially extending yoke 172 is provided by the latter wheel and opposed set screws 173 are threaded through the fork-arms of this yoke to engage a pin 174 fixed to the sprocket wheel. The two wheels are clamped together in their adjusted relationship by bolts 175 threaded in the sprocket wheel and passing through arcuate slots 176 presented by the wheel 49.

It is thought that the invention, its operation, and advantages will have been clearly understood from the foregoing description of my illustrated now-preferred embodiment. It will be understood that structural changes within the scope of the teachings may be resorted to without departing from the invention and I accordingly intend that no limitations be implied and that the hereto annexed claims be read with the broadest interpretation to which the employed language fairly admits.

I claim:

1. In a wire-weaving machine, the combination of feed means for interruptedly advancing a ganged plurality of warp wires along a prescribed travel path, means independent of said feed means acting during each of said intermittent advance periods for imposing upon the several

wires in the gang alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, means occupying a station localized with respect to said travel path and during each of said interruptions acting to feed wire stock from a supply reel and lace the leading end thereof as a woof wire through the transversely extending eyes which said propagating curves produce, means for cutting said applied woof wires to length so that the two ends project beyond each of the opposite side edges of the ganged warp wires, and means also localized with respect to said travel path beyond the localized station occupied by the last named means and also operating during said interruptions in travel for clinching the projecting ends of the applied woof wires around a related side-edge warp wire, said feed means comprising at least two rotary wheels spaced apart longitudinally of said prescribed travel path to occupy positions at opposite sides, longitudinally speaking, of the means which clinches the woof wires, each of said wheels presenting peripheral teeth spaced, center-to-center, in correspondence with the spacing of the woof wires and arranged to lodge behind the latter.

2. In a wire-weaving machine, a feed device operative when activated to advance a ganged plurality of warp wires along a prescribed travel path a distance amounting to one-half the length of a given sinusoidal curve, means for intermittently activating said feed device, top and bottom forming teeth engaging the warp wires from above and below and acting in each of the successive periods of advance to impose upon the several wires in the gang alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, a member occupying a station to one side of the travel path of the ganged warp wires mounted for reciprocal movement along a path which is transverse to the path travelled by the warp wires and during each period of interruption in the travel of said warp wires operating to draw a woof wire from a supply reel and lace the same through respective transversely extending eyes produced by said propagating curves, means for cutting said woof wires to length after the same have been laced, the applied woof wires projecting beyond each of the opposite side edges of the ganged warp wires, and means occupying stations in the paths travelled by the applied woof wires and made to operate during said periods of interruption of travel for clinching the projecting ends of the applied woof wires around a related side-edge warp wire.

3. In a wire-weaving machine, a feed device operative when activated to advance a ganged plurality of warp wires along a prescribed travel path a distance amounting to one-half the length of a given sinusoidal curve, means for intermittently activating said feed device, top and bottom forming teeth engaging the warp wires from above and below and acting in each of the successive periods of advance to impose upon the several wires in the gang alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, a shuttle occupying a station to one side of the travel path of the ganged warp wires and during each period of interruption in the travel of said warp wires operating to draw wire stock from a supply reel therefor and feed the same as a woof wire through the transversely extending eyes produced by said propagating curves, a cut-off device for severing said applied woof wires from the following wire stock the applied woof wires projecting beyond each of the opposite side edges of the ganged warp wires, and means occupying stations in the paths traveled by the applied woof wires and made to operate during said periods of interruption of travel for clinching the projecting ends of the applied woof wires around a related side-edge warp wire.

4. In a wire-weaving machine, a feed device arranged for intermittent action and operative when activated to advance a ganged plurality of warp wires along a prescribed travel path a distance amounting to one-half the length of a given sinusoidal curve, means for intermittently activating said feed device, top and bottom forming teeth independent of said feed device engaging the warp wires from above and below and acting in each of the successive periods of advance to impose upon the several wires in the gang alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, a shuttle movable reciprocally along a transverse travel path located to one side of the travel path of the ganged warp wires and during each period of interruption in the travel of said warp wires operating to draw wire stock from a supply reel therefor and feed the same as a woof wire through the transversely extending eyes produced by said propagating curves, and a device for cutting the woof wire to length and made to perform its cutting function as the shuttle completes its wire-feeding stroke of reciprocation.

5. In a wire-weaving machine, a feed device arranged for intermittent action and operative when activated to advance a ganged plurality of warp wires along a prescribed travel path a distance amounting to one-half the length of a given sinusoidal curve, means for intermittently activating said feed device, top and bottom forming teeth engaging the warp wires from above and below and acting in each of the successive periods of advance to impose upon the several wires in the gang alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, a shuttle movable reciprocally along a path of travel extending transverse to and located at one side of the travel path of the ganged warp wires, said shuttle acting in each inward stroke of reciprocation to draw wire stock from a supply reel therefor and feed the same as a woof wire through the transversely extending eyes produced by said forming teeth and being inactive to the wire in the outward return stroke of reciprocation, drive means for the shuttle, means for severing the applied woof wire from the following wire stock, the applied woof wires projecting beyond each of the opposite side edges of the ganged warp wires, and means occupying stations in the paths travelled by the projecting ends of said applied woof wires and made to operate during said periods of interruption of travel for clinching the projecting ends of the applied woof wires around a related side-edge warp wire.

6. In a wire-weaving machine, an intermittently acting feed device operative when activated to advance a ganged plurality of warp wires along a prescribed travel path a distance amounting to one-half the length of a given sinusoidal curve, means for intermittently activating said feed device, top and bottom forming teeth movable in concert with the feed device and engaging the warp wires from above and below and acting in each of the successive periods of advance to impose upon the several wires in the gang alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, a wire-engaging shuttle mounted for reciprocating transverse movement to one side of the station occupied by said forming teeth and acting in the inward advance stroke of reciprocation to draw wire stock from a supply reel therefor and feed the same as a woof wire through the transversely extending eyes produced by the forming teeth while being inactive to said stock wire in the outward return stroke of reciprocation, the leading end of each successively applied woof wire projecting beyond the outer end of the ganged warp wires, a device for severing the applied woof wires from the following wire stock and so cutting the applied woof wires that the cut end projects beyond the inner end of the ganged warp wires, and means made to operate upon said projecting ends of the applied woof wires as the same progress with the warp wires for clinching said projecting woof ends around the side-edge warp wires.

7. A wire-weaving machine according to claim 6 in

which the feed device comprises a pair of longitudinally spaced rotary wheels presenting peripheral teeth spaced, center-to-center, in correspondence with the spacing of the woof wires and arranged to lodge behind the latter.

8. Structure according to claim 7 in which the forming teeth are provided upon the perimeter of discs which are co-axial to and driven in concert with the rotary feed wheel nearest the head end of the machine.

9. A wire-weaving machine according to claim 6 in which the crimping means perform their crimping function in successive stages first bending the wire ends through somewhat more than a 90° turn relative to the general plane occupied by the concerned wire and then completing the clinch by bending the wire ends through an additional approximate 90° turn.

10. A wire-weaving machine according to claim 9 in which the two-stage crimping function is performed by a set of two jawed knucklers at least one of which is mounted for swinging movement with the axis of swing being vertically offset in the direction of the imposed bend from the plane occupied by the parent portion of the concerned wire, there being two alternately acting sets for each side of the advancing work with one set acting upon those woof wire ends which must be bent upwardly and with the other set acting upon those woof wire ends which must be bent downwardly.

11. In a wire-weaving machine, an intermittently acting feed device operative when activated to advance a ganged plurality of warp wires along a prescribed travel path a distance amounting to one-half the length of a given sinusoidal curve, a ratcheting drive for intermittently activating said feed device, top and bottom forming teeth movable in concert with the feed device and engaging the warp wires from above and below and acting in each of the successive periods of advance to impose upon the several wires in the gang alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, a wire-gripping shuttle mounted for reciprocating transverse movement to one side of the station occupied by said forming teeth and acting in the inward advance stroke of reciprocation to draw wire stock from a supply reel therefor and feed the same as a woof wire through the transversely extending eyes produced by the forming teeth while being inactive to said stock wire in the outward return stroke of reciprocation, means for driving the shuttle in its reciprocatory movement, the fed woof wires projecting laterally beyond the far side of the ganged warp wires, means for severing the applied woof wire from the following wire stock so as to leave an end of the applied woof wire projecting laterally beyond the near side of the ganged warp wires, and means occupying stations in the paths travelled by the applied woof wires and made to operate during said periods of interruption of travel for clinching the projecting ends of the applied woof wires around a related side-edge warp wire.

12. Structure according to claim 11 having means working in concert with the operation of the wire-severing means for imposing warp-fitting crimps upon a length of the stock wire lying in immediate following relation to the woof wire which is cut off by the wire-severing means.

13. A wire-weaving machine according to claim 12 in which the shuttle acts automatically to grip the stock wire in its advance travel and release the stock wire in its return travel, and wherein the crimping means maintains crimping pressure upon the stock wire during such return travel to hold the stock wire securely against liability of the latter creeping rearwardly as the shuttle returns.

14. In a wire-weaving machine, the combination of co-axial rotary discs located along a path prescribed for the travel of a ganged plurality of warp wires and in the instance of certain of said discs giving travelling energy to the wires and in the instance of others of said discs imposing upon the wires, in course of their travel, alternating positive and negative phases of propagating sinusoidal curves having the abscissa axes all occupying a common plane, means also located along said prescribed path of travel and acting in course of said travel to pass a respective woof wire through the successive transversely extending eyes which said propagating curves produce, and still additional means located along said prescribed path at a point in the travel of the wires beyond both of said recited means and acting to give travelling energy to the woven wires, the means last recited being driven in directional correspondence with the travel of the woven wires and being brought to bear directly against the woof wires.

15. The method of clinching projecting ends of woof wires contained in a woven wire screen, and which comprises advancing the woven screen along a path of travel longitudinal to the warp wires of the woven screen, momentarily interrupting said advance at regularly spaced intervals, and during successive said interruptions subjecting said projecting ends to the action of complementing pairs of opposed jaws with the first-acting pair of said jaws imposing upon the concerned wire end a bend somewhat more than 90° from the general plane of the screen and with the second-acting pair of said jaws imposing a further approximate 90° bend.

16. The method of claim 15 in which each wire end is deflected to one side of the plane occupied by the parent strand of woof wire coincident with the imposition of said first-acting bending force.

17. In a wire-weaving machine, a set of upper and lower complementing rotary wheels each presenting about its perimeter multiple axially spaced series of heddle teeth placed so that each series of teeth of the one wheel lies directly opposite a series of teeth of the other wheel and having the teeth of each series disposed at equidistant rather widely spaced intervals of the circumference, the teeth of opposite said series being positioned so that those of one series occur in the intervals between those of the other and said teeth being staggered as between adjacent said series in each wheel, at least one of said wheels preseting about its perimeter in each of the spaces between said several series of heddle teeth a respective series of circumferentially spaced driver teeth, there being twice as many driver teeth in each series of driver teeth as there are heddle teeth in each series of heddle teeth and the placement being such that successive driver teeth of each series of driver teeth have their leading edge spaced slightly to the rear one said tooth from the following edge of a heddle tooth disposed at one side and the other said tooth from the following edge of a heddle tooth disposed at the other side of the concerned series of driver teeth, and means for imparting such a rotation to the wheels as will unidirectionally and interruptedly advance each wheel, rim travel considered, distances corresponding to the center-to-center spacing of the driver teeth.

18. The machine of claim 17 in which the heddle teeth have a width approximating the diameter of the wire which is to be woven.

19. In a wire-weaving machine, a set of upper and lower complementing rotary wheels each presenting about its perimeter multiple axially spaced series of heddle teeth placed so that each series of teeth of the one wheel lies directly opposite a series of teeth of the other wheel and having the teeth of each series disposed at equidistant rather widely spaced intervals of the circumference, the teeth of opposite said series being positioned so that those of one series occur in the intervals between those of the other and said teeth being staggered as between adjacent said series in each wheel, at least one of said wheels presenting about its perimeter in each of the spaces between said several series of heddle teeth a respective series of circumferentially spaced driver teeth, there being twice as many driver teeth in each series of driver teeth as there are heddle teeth in each series of heddle teeth and

the placement being such that successive driver teeth of each series of driver teeth have their following edge transversely aligned one said driver tooth with the following edge of a heddle tooth disposed at one side and the other said driver tooth with the following edge of a heddle tooth disposed at the other side of the concerned series of driver teeth, and means for imparting such a rotation to the wheels as will unidirectionally and interruptedly advance each wheel, rim travel considered, distances corresponding to the center-to-center spacing of the driver teeth.

20. In a wire-weaving machine, a set of upper and lower complementing rotary wheels each presenting about its perimeter multiple axially spaced series of heddle teeth placed so that each series of teeth of the one wheel lies directly opposite a series of teeth of the other wheel and having the teeth of each series disposed at equidistant rather widely spaced intervals of the circumference, the teeth of opposite said series being positioned so that those of one series occur in the intervals between those of the other and said teeth being staggered as between adjacent said series in each wheel, at least one of said wheels presenting about its perimeter in each of the spaces between said several series of heddle teeth a respective series of circumferentially spaced driver teeth, there being twice as many driver teeth in each series of driver teeth as there are heddle teeth in each series of heddle teeth and the placement being such that successive driver teeth of each series of driver teeth have their leading edge spaced slightly to the rear one said tooth from the following edge of a heddle tooth disposed at one side and the other said tooth from the following edge of a heddle tooth disposed at the other side of the concerned series of driver teeth, means for imparting such a rotation to the wheels as will unidirectionally and interruptedly advance each wheel, rim travel considered, distances corresponding to the center-to-center spacing of the driver teeth, and cross-wire feed means including a shuttle reciprocally movable along a travel path disposed wholly at one side of the recited set of wheels and operating in the interval of time between said interrupted advances of the wheels.

21. The machine of claim 20 in which the driver teeth function to interruptedly move a ganged plurality of warp wires between said rotary wheels in positions such that each pair of opposite said series of heddle teeth impose upon a respective said warp wire alternating positive and negative phases of propagating sinusoidal waves, the abscissa axes of said several waved wire all occupying a common plane, and wherein the path travelled by the shuttle is aligned with the transversely extending eyes which said propagating waves produce.

22. In a wire-weaving machine, a set of upper and lower complementing rotary wheels each presenting about its perimeter multiple axially spaced series of heddle teeth placed so that each series of teeth of the one wheel lies directly opposite a series of teeth of the other wheel and having the teeth of each series disposed at equidistant rather widely spaced intervals of the circumference, the teeth of opposite said series being positioned so that those of one series occur in the intervals between those of the other and said teeth being staggered as between adjacent said series in each wheel, at least one of said wheels presenting about its perimeter in each of the spaces between said several series of heddle teeth a respective series of circumferentially spaced driver teeth, there being twice as many driver teeth in each series of driver teeth as there are heddle teeth in each series of heddle teeth and the placement being such that successive driver teeth of each series of driver teeth have their leading edge spaced slightly to the rear one said tooth from the following edge of a heddle tooth disposed at one side and the other said tooth from the following edge of a heddle tooth disposed at the other side of the concerned series of driver teeth, means for imparting such a rotation to the wheels as will unidirectionally and interruptedly advance each wheel, rim travel considered, distances corresponding to the center-to-center spacing of the driver teeth, said driver teeth functioning to interruptedly advance a ganged plurality of warp wires between said rotary wheels in positions such that each pair of opposite said series of heddle teeth impose upon a respective said warp wire alternating positive and negative phases of propagating sinusoidal waves, the abscissa axes of said several waved wires all occupying a common plane, feed means operating in the interval of time between said interrupted advances of the wheels for lacing a respective woof wire through the transversely extending eyes which said propagating waves produce, the applied woof wires projecting beyond each of the opposite side edges of the ganged warp wires, and means associated with said wheels and operating upon the projecting ends of said laced woof wires as the latter move beyond the wheels for clinching the projecting ends of the applied woof wires around a related side-edge warp wire.

23. The machine of claim 22 in which the means for rotating the wheels, the means for feeding the woof wires, and the means for clinching the projecting ends of the woof wires are each powered by a respective hydraulically operated means, a source of hydraulic power common to all of said hydraulically operated means, and means controlling the operation of said several hydraulically operated means so as to obtain timed activation of the latter by energy derived from the source.

24. A machine according to claim 22 wherein another rotary wheel driven in concert with the rotation of the first-named wheels is provided at the tail end of the machine to act in complement with said driver teeth for giving travelling motion to the wire screen which is being woven, said tail wheel providing driver teeth formed substantially as counterparts of the first-named driver teeth.

25. In a wire-weaving machine, a set of upper and lower complementing rotary wheels, each rim composed of multiple co-axial discs which are, comparatively speaking, alternately wide and narrow as between the several discs of each wheel and with both the wide and narrow discs of the one wheel directly opposite the wide and narrow discs, respectively, of the other wheel, each of said narrow discs presenting about its perimeter a series of heddle teeth spaced at equidistant intervals of the circumference and positioned so that the teeth of one wheel loosely mesh the teeth of the other wheel and being characterized in that each of the several narrow discs both of the upper and of the lower wheel of a next adjacent narrow disc in the respective wheel, each of the wide discs of one of said wheels presenting a series of driver teeth spaced at equidistant intervals of the circumference, there being twice as many driver teeth on each driver disc as there are heddle teeth on each heddle disc and the placement being such that successive driver teeth of each driver disc have their leading edge spaced slightly to the rear one said tooth from the following edge of a heddle tooth disposed at one side and the other said tooth from the following edge of a heddle tooth disposed at the other side of the concerned driver disc, and means for imparting such a rotation to the wheels as will unidirectionally and interruptedly advance each wheel, rim travel considered, distances corresponding to the center-to-center spacing of the driver teeth.

26. In a wire-weaving machine, a set of upper and lower complementing rotary wheels each composed of multiple co-axial discs which are, comparatively speaking, alternately wide and narrow as between the several discs of each wheel and with both the wide and narrow discs of the one wheel directly opposite the wide and narrow discs, respectively, of the other wheel, each of said narrow discs presenting about its perimeter a series of heddle teeth spaced at equidistant intervals of the circumference and positioned so that the teeth of one wheel

loosely mesh the teeth of the other wheel and being characterized in that each of the several narrow discs both of the upper and of the lower wheel has its teeth so placed as to occur intermediate the teeth of a next adjacent narrow disc in the respective wheel, each of the wide discs of one of said wheels functioning solely as spacers and those of the other wheel operating as drivers and presenting a series of driver teeth spaced at equidistant intervals of the circumference, there being twice as many driver teeth on each driver disc as there are heddle teeth on each heddle disc and the placement being such that successive driver teeth of each driver disc have their leading edge spaced slightly to the rear one said tooth from the following edge of a heddle tooth disposed at one side and the other said tooth from the following edge of a heddle tooth disposed at the other side of the concerned driver disc, and means for imparting such a rotation to the wheels as will unidirectionally and interruptedly advance each wheel, rim travel considered, distances corresponding to the center-to-center spacing of the driver teeth.

27. The machine of claim 25 in which the narrow discs have a width approximating the diameter of the wire which is to be woven.

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